Cruise Results for the 2007 Eastern Bering Sea Crab and Groundfish Survey

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INTRODUCTION

The Resource Assessment and Conservation Engineering (RACE) Division of the National Oceanic and Atmospheric Administration's (NOAA) Alaska Fisheries Science Center (AFSC) conducted the Eastern Bering Sea Crab and Groundfish Survey from June to August 2007. This cruise continued the annual series of eastern Bering Sea crab and groundfish stock assessment surveys, which began in 1971. The survey covered the Bering Sea shelf, between the depths of 20 and 200 m, from Bristol Bay to St. Lawrence Island.

OBJECTIVES

The primary objective of this survey was to provide the following:

1. Data on the distribution, abundance, and biological condition of commercially important groundfish and crab species for the North Pacific Fishery Management Council (NPFMC).
2. Catch per unit effort (CPUE) and size composition data for the commercial fisheries of the U.S.
3. Support for ongoing studies on the biology, behavior, and dynamics of key ecosystem components.

Secondary objectives comprised:

1. Conducting additional sampling in areas of high king crab and Tanner crab abundance to reduce variance in population estimates.
2. Evaluating the calibration of the trawl warps and the performance and geometry of the trawl using net mensuration sensors.
3. Collecting and preserving voucher specimens of fish and invertebrates for taxonomic study.
4. Collecting stomach samples for trophic interaction research.
5. Collecting and preserving both fish and invertebrate specimens for approved Special Project requests.
6. Trawling in cooperation with the Bering Sea Fisheries Research Foundation (BSFRF) in Bristol Bay to do a preliminary comparison of red king crab catchability between the standard RACE trawl gear for the Bering Sea shelf and the proposed BSFRF study gear.
7. Resampling stations in Bristol Bay at the end of the survey to document the delayed onset of molting (i.e. reproductive) red king crab.

VESSELS AND GEAR

Sampling at survey stations was coordinated between two chartered commercial fishing vessels, the F/V *Arcturus* and F/V *Aldebaran*. Both vessels are house-forward trawlers with stern ramps. The LOA of each vessel was 39.6 m (130 ft).

The bottom trawl used for sampling was an 83-112 eastern trawl. These nets have a 25.3 m (83 ft) headrope and a 34.1 m (112 ft) footrope (Figure 1). They were towed behind 816 kg, 1.8 X 2.7 m, steel V-doors and paired 54.9 m (180.1 ft) dandylines. Each lower dandyline had a 61 cm chain extension connected to the lower wing edge to improve bottom tending characteristics.

A digital bathythermograph was attached to the headrope and deployed with each trawl, resulting in oblique depth/temperature profiles of the water column. A bottom contact sensor (inclinometer) provided data to assess bottom tending performance and to determine when the footrope was in contact with the seafloor. Net mensuration sensors were also used to assess trawl performance and to provide net geometry data to calculate the area swept by the trawl.

ITINERARY

The charters of the *Arcturus* and *Aldebaran* began in Dutch Harbor, Alaska on June 4, 2007. Intermediate port calls were made to Dutch Harbor on June 23 and July 12 to exchange scientific personnel. An additional port call was made at St. Paul Island on July 2 to exchange vessel personnel and some members of the scientific party. The standard survey was completed on August 2, 2007 and both vessels were offloaded in Dutch Harbor.

Prior to the beginning of the survey, both vessels marked the trawl warps with paint at 45.73 m (25 fm) intervals. The vessels' geometric counter readouts were verified and calibrated to the marks on the trawl warps to ensure that consistent lengths of wire were deployed at all sampling stations for a given depth.

SURVEY DESIGN AND METHODS

The total standard survey area encompassed approximately 463,400 km^2. Sampling stations were based on a 37.04 km (20 nm) square grid pattern established during previous surveys. However, high density sampling was conducted in the Pribilof Islands and St. Matthew Island regions to collect supplemental data on crab populations. For reporting purposes, the survey area is divided into strata (Figure 2) that correspond to the inner (0 – 50 m), middle (51 – 100 m), and outer (> 100 m) Bering Sea shelf domains, which are further divided into northwest and southeast geographical strata. Since 1982, 20 stations outside of these strata have been added to standard survey sampling, but these are not included in this analysis.

Sampling began in Bristol Bay and proceeded westward to the Bering Sea shelf edge, determined by the 200 m isobath. Toward the end of the charter, the *Aldebaran* returned to Bristol Bay to resurvey 30 stations in an effort to verify the reproductive status of red king crab in this area.

Figure 2 details the distribution of standard sampling for the 2007 survey by vessel. Trawls were 30 minutes in duration, as estimated from the time the footrope made contact with the seafloor until the time the footrope was completely off-bottom as the net was hauled back. At each station, observations of time, position, trawl performance and distance fished were recorded. All catches were sorted to the lowest possible taxon, weighed, and enumerated. Age, size composition, and other biological data were collected for the major fish species encountered. Catch and station data were entered into shipboard computer systems. Carapace length and width, shell condition and clutch size were observed and recorded from the major crab species, and various tissues and organs were collected for further analysis. Collections for approved Special Projects were stored in appropriate fixatives or were frozen.

RESULTS

The *Arcturus* and *Aldebaran* conducted 384 bottom trawls in the execution of the standard survey. Of those trawls, 8 were determined to have unsatisfactory performance, resulting in retowing at those stations for acceptable performance.

Biological data collected from fish species are summarized in Table 1. The two vessels recorded 161,504 randomly selected length measurements by sex from priority fish species. To facilitate age analysis, sagittal otoliths were extracted from 7,481 fish, stratified by size and sex per species, and preserved for age analysis. Additionally, vertebrae sections were extracted from 112 Alaska skates for age determination as part of a Special Project. Correlated length/weight measurements were also recorded during the otolith and skate vertebrae collection processes. A total of 4,215 fish stomachs were either scanned and recorded or preserved for feeding habit analysis.

Whole specimens of selected fish and invertebrate species were preserved for use in identification training programs and other research. Various tissue samples were removed and preserved for approved research projects.

Table 2 contains the percentage of all stations sampled where fish or commercial crab species, excluding non-commercial invertebrates, accounted for the majority of the catch by weight. Catch rates of commercial fish and crab species are listed by Stratum and total survey area in Table 3. Catch per unit effort (CPUE) is calculated as the total weight of a species in a given tow, divided by the product of the distance fished and the average net width from the time the footrope contacted the seafloor until the footrope was no longer in contact with the bottom.

Walleye pollock (*Theragra chalcogramma*) were the most abundant roundfish species and had an overall catch per unit effort (CPUE) of 89.70 kg/ha. Pollock were encountered at most sampling stations (Figure 3), with the largest mean catches (248.56 kg/ha) observed in Stratum 6 at depths of 81-171 m. The catch rate was much lower within relatively shallower Strata 1 and 2 (3.15 and 3.65 kg/ha respectively).

Yellowfin sole (*Limanda aspera*) and northern rock sole (*Lepidopsetta polyxystra*) were the most abundant flatfish species with overall CPUE values of 46.46 kg/ha and 43.87 kg/ha respectively. The catch rates for yellowfin sole and northern rock sole were highest in Stratum 1, with respective CPUE values of 126.81 kg/ha and 120.02 kg/ha. Yellowfin sole were encountered at only the southeasternmost station in Stratum 5 and were not encountered at all in Stratum 6 (Figure 4).

Pacific cod (*Gadus macrocephalus*) were encountered at most of the sites sampled (Figure 6). Mean catches were smallest in Stratum 5 (3.56 kg/ha), where Pacific cod were not caught in several stations. The greatest mean catches occurred in Stratum 6 (14.39 kg/ha) with a total CPUE of 9.14 kg/ha over all strata.

Catch rates for Pacific halibut (*Hippoglossus stenolepis*) were highest in Stratum 2 (5.62 kg/ha), but were fairly consistent between all strata with a total CPUE of 3.11 kg/ha. The highest catch rates for Alaska plaice (*Pleuronectes quadrituberculatus*) occurred in Stratum 2 as well (15.46 kg/ha). The highest combined catch rates for flathead sole (*Hippoglossoides elassodon*) and Bering flounder (*H. robustus*) occurred in Strata 3 and 6 (19.18 kg/ha and 20.75 kg/ha respectively). Combined catch rates for arrowtooth flounder (*Atherestes stomias*) and Kamchatka flounder (*A. evermanni*) peaked in Stratum 5 (41.81 kg/ha).

Opilio Tanner crab (*Chionocetes opilio*) was the most abundant commercial crab species encountered, having a total CPUE of 5.55 kg/ha with the largest mean catches occurring in Stratum 4 (15.67 kg/ha). The catch rate for Bairdi Tanner crab (*C. bairdi*) was less overall (2.60 kg/ha), but it was considerably higher in Stratum 5 (7.78 kg/ha) than Opilio Tanner crab (0.63 kg/ha). Red king crab (*Paralithodes camtschatica*) had a total CPUE of 1.98 kg/ha and was most abundant in Stratum 3 (4.08 kg/ha), but none were caught in Strata 5 and 6. Blue king crab (*P. platypus*) had an overall catch rate of 0.18 kg/ha and occurred only in Strata 4 and 6.

The mean near-bottom temperature (measured as the average temperature at the depth of the headrope while the trawl was on-bottom) was colder in 2007 than in 2006, though the survey began later in 2007 than previously. The mean near-bottom temperature in 2006 was significantly colder than in the previous 5 years (Figure 7) at the same time of year. The colder bottom temperatures may have delayed the molting and spawning of female red king crab. This led to a resampling of 32 stations (33 trawls) in Bristol Bay toward the end of the charter, allowing time for females to molt successfully and develop clutches. The mean temperature for these stations had increased from 1.6 °C to 3.3 °C between the original survey and the resurvey, and greater numbers of gravid females were observed.

SPECIAL PROJECTS

Auxiliary to the standard survey sampling, 27 Special Projects were undertaken on the 2007 Eastern Bering Sea Crab and Groundfish Survey (Table 4). The deadline for Special Project proposals was March 30, 2007. The proposals were reviewed by the Bering Sea Subtask of the RACE Groundfish Assessment Program and were accepted based on feasibility, scientific value, and impact to standard operating procedures. Projects submitted by 6 institutions were approved. Data for these projects were collected at sea and disseminated to the requesting principle investigator(s). To acquire the details of any Special Project, please contact the investigator(s) designated in Table 4.

Prior to the commencement of the survey, trawls were conducted in cooperation with the BSFRF to determine the comparability of newly designed gear with the standardized gear and trawling procedures used on the RACE Bering Sea shelf surveys. From June 9 – 10, the *Arcturus* and *Aldebaran* conducted 21 trawls (including 1 unsatisfactory trawl) in Bristol Bay, while the F/V *American Eagle*, chartered by the BSFRF, conducted trawls, parallel to either the *Arcturus* or *Aldebaran*, at the same time and in the same direction.

SCIENTIFIC PERSONNEL[a]

F/V *Arcturus*

Leg 1[b]	Leg 2	Leg 3
D. Stevenson[c]	J. Conner[c]	L. Britt[c]
B. Lauth[d]	B. Lauth/L. Britt[d, h]	J. Conner[d]
L. Chilton[e]	C. Armistead[e]	L. Rugulo[e]
J. Brogan	L. Slater[g]	L. Chilton[e]
C. Shavey	V. Lowe	C. Shavey
J. Clark	L. Logerwell	T. Tenbrink

F/V *Aldebaran*

Leg 1[b]	Leg 2	Leg 3
K.Weinberg[c]	D.Nichol[c]	S. Kotwicki[c]
S. Kotwicki[d]	E. Acuna[d]	J. Hoff[d]
S. VanSant[e]	P. Cummiskey[e]	E. Munk[e]
J. Webb[g]	D. Benjamin	D. Benjamin
C. Clarke[f]	C. Clarke[f]	D. Barrett[f]
G. Lang	K. Dodd	A. Whitehouse

[a] Personnel from the AFSC, Seattle, unless otherwise noted
[b] Leg dates: Leg 1 (6/4 - 6/22); Leg 2 (6/23 – 7/11); Leg 3 (7/12 – 8/2)
[c] Field Party Chief
[d] Deck Boss
[e] Personnel from the AFSC, Kodiak Laboratory
[f] Personnel from the International Pacific Halibut Commission
[g] Personnel from the Alaska Department of Fish & Game
[h] Exchanged on 7/2 at St. Paul Island

Table 1 - Biological data collected during the 2007 Eastern Bering Sea Crab and Groundfish Survey.

Species	Length Measurements	Age Structures[1]	Stomachs Collected	Stomachs Scanned
Walleye pollock	29,679	1,492	435	668
Pacific cod	13,441	1,461	609	-
Yellowfin sole	24,790	779	-	-
Northern rock sole	28,467	485	-	-
Flathead sole/ Bering flounder[2]	17,811	868	-	-
Pacific halibut	3,754	1,570	193	246
Alaska plaice	11,729	343	157	-
Arrowtooth flounder/ Kamchatka flounder[3]	13,308	-	536	315
Greenland turbot	499	334	223	6
Rex sole	975	-	-	-
Longhead dab	1,456	-	-	-
Plain sculpin	2,622	-	-	-
Great sculpin	748	-	41	-
Warty sculpin	332	-	11	-
Yellow Irish lord	394	73	53	-
Starry flounder	1,128	-	183	-
Pacific Ocean perch	44	-	-	-
Alaska skate	4,997	112	330	-
Bering skate	222	-	47	-
Misc. skates	19	-	3	-
Misc. species	5,089	76	138	21
Total	161,504	7,593	2,959	1,256

[1] Individual length-weight data were also collected.
[2] Age structures were collected from flathead sole only.
[3] Age structures were collected from arrowtooth flounder only.

Table 2 – Percentage and number of all survey stations where the specified fish or commercial crab species predominated a haul by weight during the 2007 Eastern Bering Sea Crab and Groundfish Survey.

Species	**Percent of Stations**	**Number of Stations**
Walleye pollock	31	116
Yellowfin sole	24	91
Northern rock sole	16	60
Opilio Tanner crab	10	37
Arrowtooth flounder	7	25
Alaska plaice	5	17
Flathead sole	4	16
Pacific cod	2	7
Alaska skate	1	5
Warty sculpin	< 1	1
Bering flounder	< 1	1

Table 3 – CPUE (kg/ha) of commercially important species by Stratum during the 2007 Eastern Bering Sea Crab and Groundfish Survey

Species	Stratum						Total
	1	2	3	4	5	6	
Walleye pollock	3.15	3.65	104.25	38.58	70.59	248.56	89.70
Yellowfin sole	126.81	105.29	58.06	12.38	0.02	NC*	46.46
Northern rock sole	120.02	96.35	35.22	28.84	0.58	2.74	43.87
Pacific cod	5.85	4.84	6.55	13.06	3.56	14.39	9.14
Alaska plaice	10.62	15.46	13.72	12.00	NC	0.49	9.10
Flathead sole/ Bering flounder	2.04	0.04	19.18	8.20	16.38	20.75	13.91
Arrowtooth flounder/ Kamchatka flounder	0.12	NC	13.16	2.52	41.81	23.29	13.45
Pacific halibut	5.09	5.62	2.94	1.93	1.77	2.49	3.11
Opilio Tanner crab	0.01	0.45	2.58	15.67	0.63	6.02	5.55
Bairdi Tanner crab	0.28	0.56	3.02	3.74	7.78	1.49	2.60
Blue king crab	NC	NC	NC	0.74	NC	0.03	0.18
Red king crab	5.40	0.37	4.08	0.55	NC	NC	1.98

* NC = None caught within the Stratum.

Table 4 – Special Projects and collections undertaken during the 2007 Eastern Bering Sea Crab and Groundfish Survey.

Project Title	**Principle Investigator**	**Agency**
Alaska skate vertebrae collection	Gerald R. Hoff	AFSC - RACE
Assessment of net swapping procedures on variability in survey trawl performance	Stan Kotwicki	AFSC - RACE
Bering Sea octopus study	Elaina Jorgensen	AFSC - RACE
Bering Sea Pacific Cod Visual Maturity and Ovary Collection	Sandi Neidetcher, Libby Logerwell	AFSC - REFM
Bitter Crab Syndrome in North Pacific *Chionoecetes* spp.	Frank Morado	AFSC - RACE
DNA barcoding the marine fish of Alaska	Mike Canino	AFSC - RACE
DNA-based identification library of prey items	Pam Jensen, Frank Morado, Troy Buckley, Kerim Aydin, Bobette Dickerson	AFSC - RACE / REFM / NMML
Effect of light intensity and light penetration on the distribution and behavior of walleye pollock in the eastern	Stan Kotwicki	AFSC - RACE
ES-60 transects at cruising speeds	Paul G. von Szalay	AFSC - RACE
Examining groundfish feeding ecology through stable isotope analysis	Kerim Aydin, Katie Dodd	AFSC - REFM
Genetic stock assessment of the Alaska skate, *Bathyraja parmifera*	Gerald R. Hoff	AFSC - RACE
Ichthyophonus in walleye pollock	Vanessa Lowe, Frank Morado	AFSC - RACE
IPHC sampler aboard one vessel to collect halibut data	Lauri Sadorus	IPHC

Table 4 – Continued

Keys to the Decapod Crustaceans of Alaska	Aaron Baldwin	Sheldon Jackson College
Live skate egg collection	Gerald R. Hoff	AFSC - RACE
Molecular Species Identification of deepwater corals	Linda Park	NWFSC - CB
Monitoring trawl gear performance	Ken Weinberg	AFSC - RACE
Reproductive potential of Bristol Bay red king crab and eastern Bering Sea snow crab	Kathy Swiney	AFSC - RACE
Reproductive potential of snow and Tanner crabs in the eastern Bering Sea	Laura Slater, Joel Webb	ADF&G
Sand lance (*Ammodytes*) Taxonomy	Jay Orr	AFSC - RACE
Stationary seabird surveys (Seabird Point Counts)	Shannon Fitzgerald	AFSC - REFM
Summer zooplankton biomass on the eastern Bering Sea shelf	Jeff Napp, Jay Clark	AFSC - RACE
Trawl gear comparison study in Bristol Bay, Alaska	Scott Goodman, Robert Lauth	BSFRF - NRC / AFSC - RACE
Trophic interactions and feeding ecology of eastern Bering Sea fishes	Kerim Aydin, Troy Buckley	AFSC - REFM
Use of EBS survey acoustic data to augment the MACE EIT walleye pollock abundance time series	Taina Honkalehto, Chris Wilson	AFSC - RACE
Weight/length data for commercial crab collected in EBS survey	Liz Chilton	AFSC - RACE
Yellow Irish lord (*Hemilepidotus jordani)* ovary collection on Leg 2	Todd TenBrink	AFSC - REFM

83/112 EASTERN

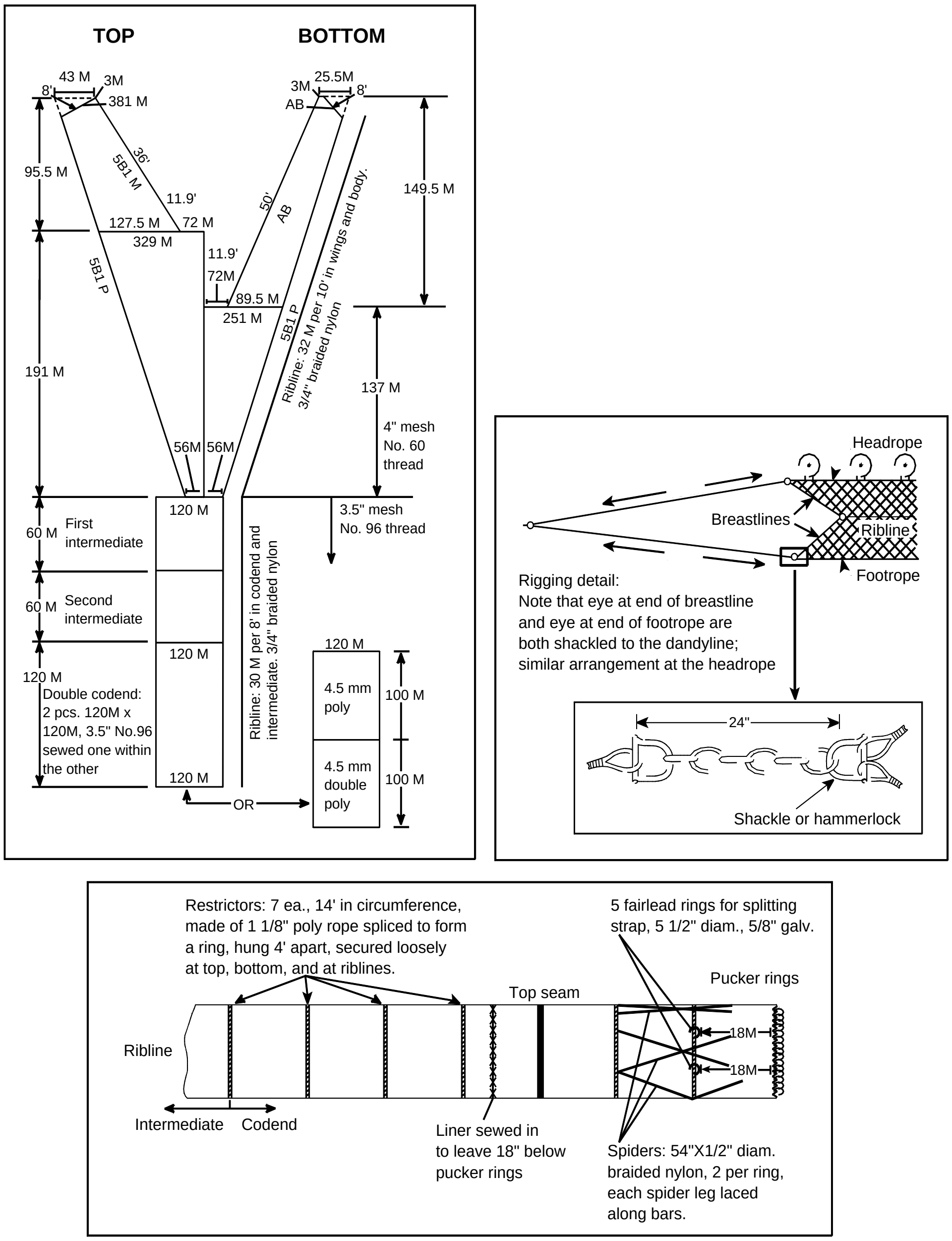

Figure 1 - Diagram of the 83-112 eastern bottom trawl used in the 2007 Eastern Bering Sea Crab and Groundfish Survey.

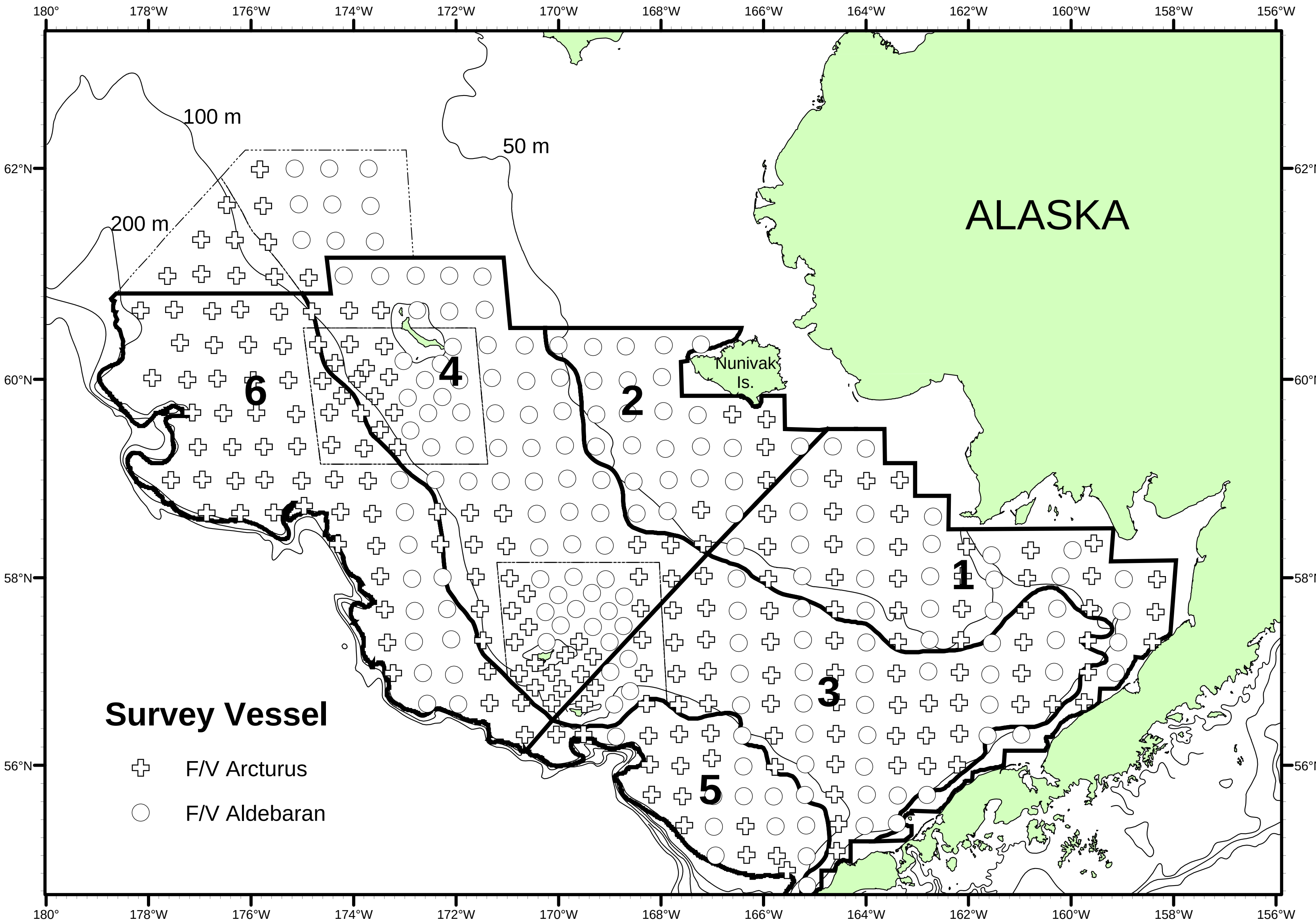

Figure 2 - Distribution of total sampling effort by the F/V *Arcturus* and F/V *Aldebaran* during the 2007 Eastern Bering Sea Crab and Groundfish Survey.

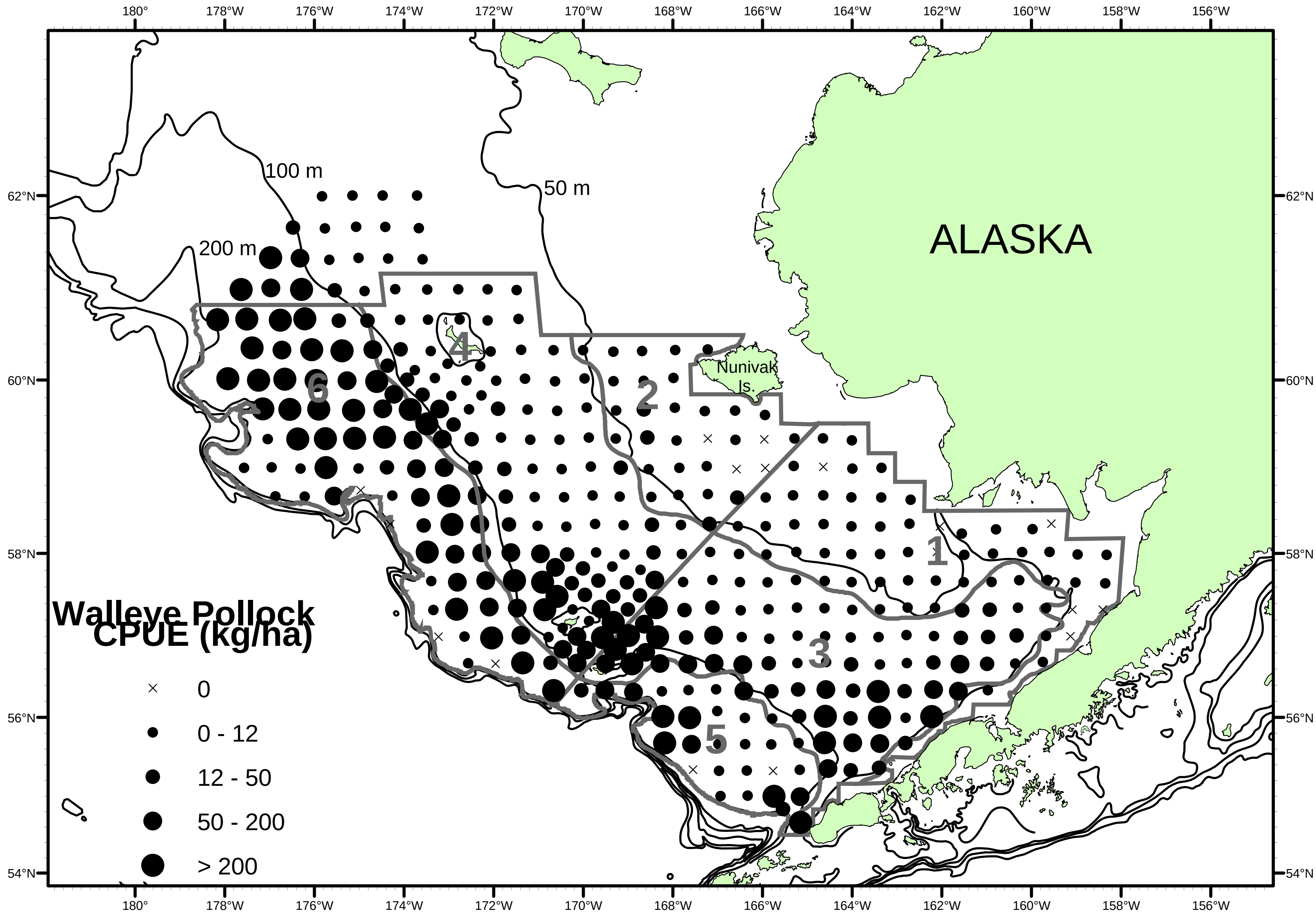

Figure 3 - Catch rates (kg/ha) of walleye pollock during the 2007 Eastern Bering Sea Crab and Groundfish

Survey.

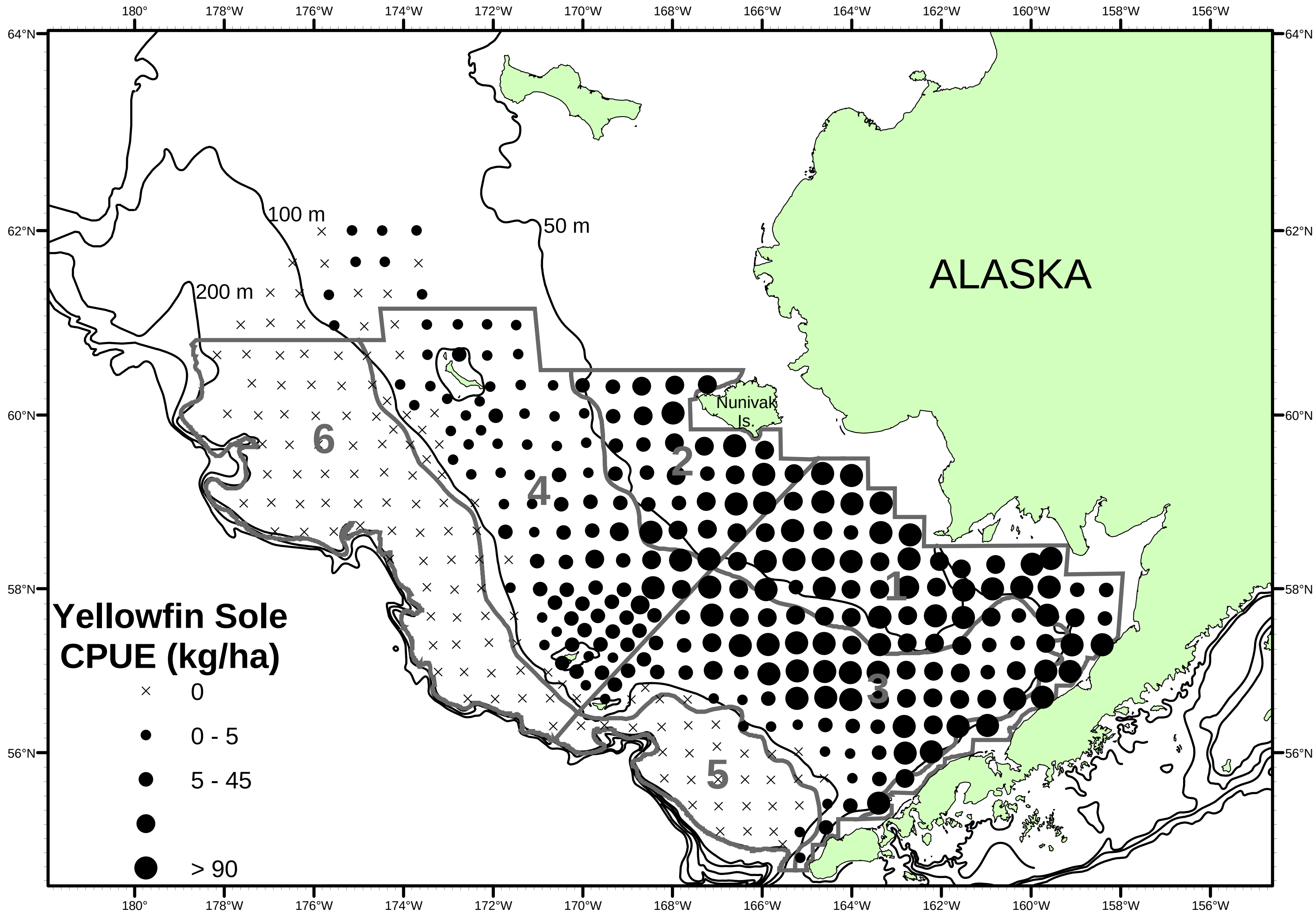

Figure 4 - Catch rates (kg/ha) of yellowfin sole during the 2007 Eastern Bering Sea Crab and Groundfish Survey.

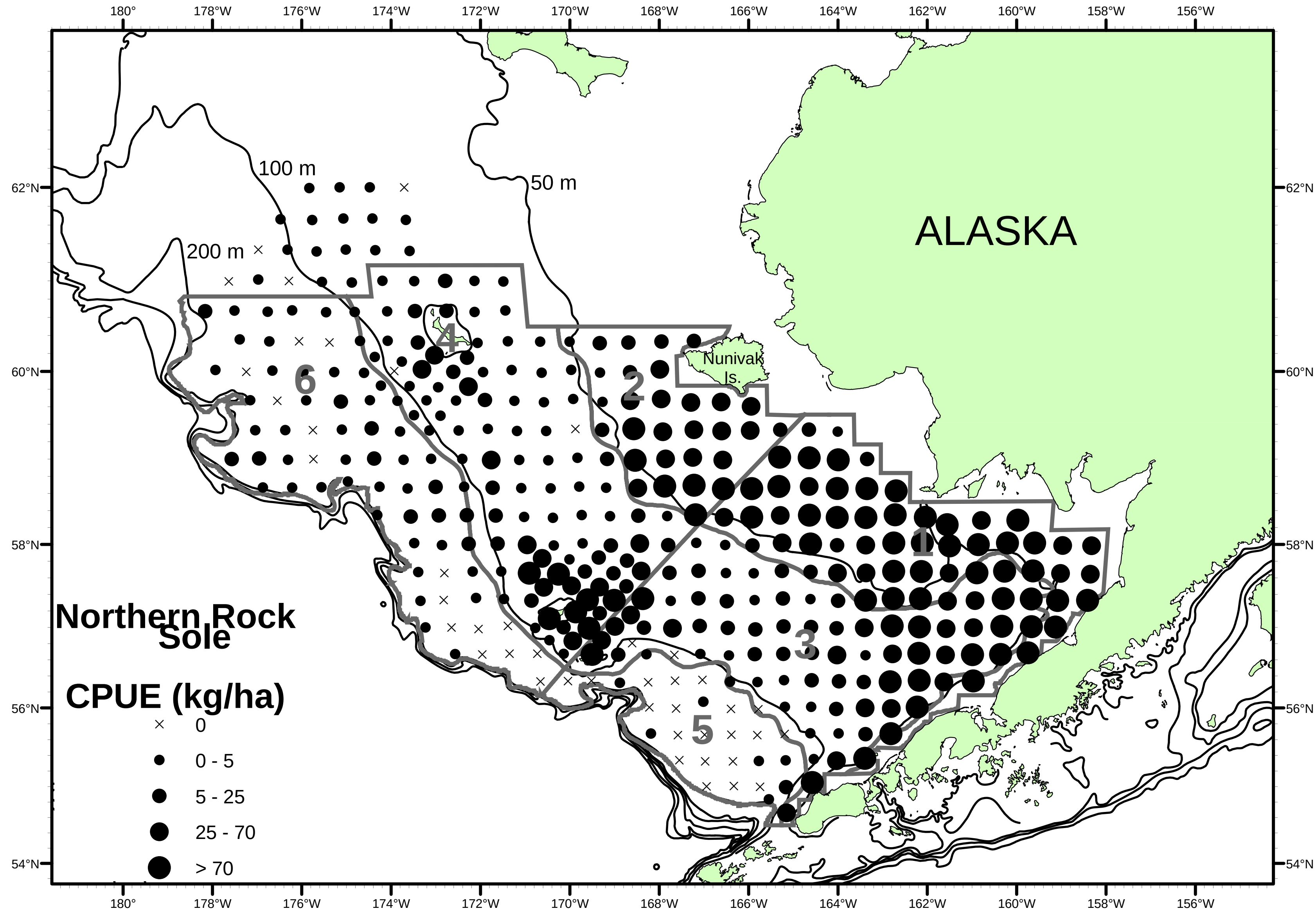

Figure 5 - Catch rates (kg/ha) of northern rock sole during the 2007 Eastern Bering Sea Crab and Groundfish

Survey.

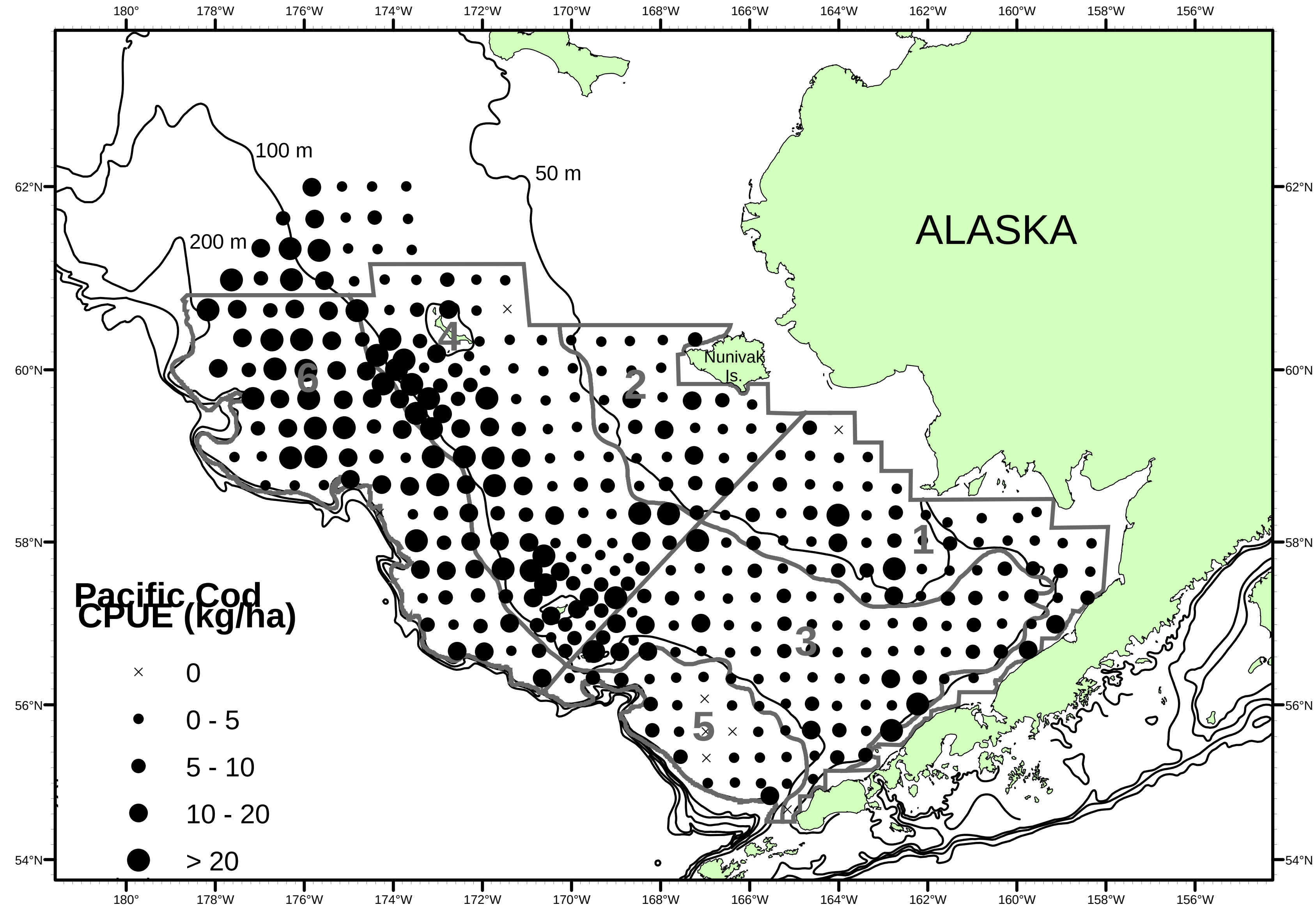

Figure 6 - Catch rates (kg/ha) of Pacific cod during the 2007 Eastern Bering Sea Crab and Groundfish Survey.

Figure 7 – Analysis of means of near-bottom temperatures (° C) recorded during the Eastern Bering Sea and Groundfish Survey for
The dashed lines represent the 95% decision limits around the grand mean.

each of the years between 2001 and 2007.